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RAINFALL AND CROPPING PATTERNS

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WEST BENGAL

CONTENTS

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WEST BENGAL

INTRODUCTION

1.1 The human population of the country is estimated to rise from the 1971 Census figure of 548 million to 935 million in 2000 AD. This rise calls for increased production. Land resources being limited emphasis has to be placed on increasing productivity per unit area. Temperature and other climatic conditions being favourable for crop production throughout the year over most parts of the country, it is possible to grow more than one crop in a year provided water, the most important input, is available. In some parts of the country, the rainy season is long enough to provide scope for double cropping. This potential is yet to be fully exploited. There is scope for increasing irrigation resources in the country, but our estimates show that the area under irrigation is not expected to be more than 42 per cent of the total cropped area even in 2000 AD as against 22 per cent in 1970-71. Therefore, judicious utilisation of direct rainfall and irrigation water, singly and in combination, will have to be thought of for increasing production.

1.2 Farming technology has so advanced that it is possible to increase crop yields even under rainfed conditions, but the choice of crops would have to depend upon the amount and distribution of the prevailing rainfall. Additionally, it will be necessary that the maximum possible quantity of rain water is conserved in ponds and pools situated either within the farm area or elsewhere, in soil profiles and underground storages so that the same could be readily used to save crops in times of water stress. Not only in rainfed farming but even under irrigated conditions, one will have to plan for the most economic and efficient use of water so as to derive maximum possible benefit from rainfall and reduce dependence on irrigation. This necessitates a close study of the existing cropping patterns vis-a-vis rainfall patterns aimed at determining the nature of changes needed in the former. The cropping patterns depend primarily on the soil and climatic factors but the evolution of a cropping pattern in course of time is the combined effect of soil, climate, food habits and requirements and economic factors. In the context of increasing production, it is necessary to examine the cropping patterns from a scientific angle and find out possible alternative patterns having higher potential. Accordingly, the Commission undertook a comprehensive study of the rainfall and cropping patterns of the country using taluk or tehsil as unit of area. It covered several other relevant factors such as orography, land use data, human and livestock populations, soil and climate, the object being to make, as far as possible, an integrated assessment.

1.3 Chapter 14 on Rainfall and Cropping Patterns of the Commission's Report presents a consolidated account of the data collected together with analysis of their inter-relationships on all-India basis. In this analysis the Commission has been greatly benefited by the discussions with the concerned officers of State Governments. It was realised that by condensing the vast amount of information collected from each State into the small space of a chapter, many important and peculiar features of individual States were likely to be missed and hence the data and analysis of each State have been presented in separate volumes. The manner of presentation is similar to Chapter 14. It has also been considered desirable to include in each State volume the methodology and suggestions for future cropping patterns, which are practically the same as given in Chapter 14.

2 METHODOLOGY

2.1 The chief features of the study are (a) use of taluk or tehsil as unit of area for all basic data and analysis (in the case of West Bengal taluk-wise data are not available and as such district is used as the unit of area); (b) introduction of coded numerical forms to express patterns of distribution of monthly rainfall throughout the year, crops and livestock; (c) inclusion of information on orography, temperature, evapotranspiration, rainfall, soil, irrigation, land use, human and livestock populations and yield performance of crops, all of which influence in different ways and degrees the cropping patterns of a place and (d) presentation of coded information on rainfall, crops and livestock on 1 : 1 million scale maps.

Rainfall Patterns

2.2 A major feature of Indian rainfall is that the southwest monsoon season (June to September) accounts for 70 to 95 per cent of the annual rainfall throughout the country except in the south east peninsula and Kashmir and adjoining hill areas. The monsoon as well as the annual rainfall show large fluctuations from year to year but, as stated in Chapter 13 on Climate and Agriculture, there is no

significant evidence of any trend or periodicity in either of them.' Considered in relation to crop production, the total annual or seasonal rainfall does not have much significance and what is important is its distribution during the period of growth of different crops. A relevant question, therefore, is whether rainfall should be examined on a weekly, fortnightly or monthly basis. The coefficient of variation (CV) of monthly rainfall is as high as 40-50 per cent even in the rainiest month of July over most of the central, northern and eastern India. In the south excluding the west coast, CV is higher and varies from 60 to 100 per cent. The variability of weekly or fortnightly rainfall being still greater, makes the use of either of them undependable as indicators of rainfall distribution. For a macro-study like the present monthly rainfall data which are more dependable and also the most convenient to handle have been used.

2.3 In order to relate crop production with rainfall, certain norms have to be assumed depending on the duration of the crops and their water requirements. On the basis of available information and the fact that most crops nature in about 90 days, the following broad norms have been drawn up :

(i) Rainfall greater than 30 cm per month (cm pm) for at least three consecutive months would be suitable for a crop like paddy whose water need is very high.

(ii) 20-30 cm pm for not less than three consecutive months would be suitable for crops whose water need is high but less than that of paddy, for example, maize and black gram.

(iii) 10-20 cm pm for at least three consecutive months would be suitable for crops requiring much less water, e.g., bajra and small millets.

(iv) 5-10 cm pm for three consecutive months would be just sufficient for crops which have low water requirements, e.g., *moth* (*P. aconitifolius*) and ephemeral grasses.

(v) Rainfall less than 5 cm pm for three consecutive months is not of much significance for crop production.

2.4 For denoting the year's rainfall distribution using monthly totals, a convenient code in letter symbols with numerical subscripts explained below, has been evolved. The letters A to E in Table 1 indicate the ranges of monthly rainfall and the subscripts to these refer to the number of months having these ranges of rainfall e.g. A_2 indicates two months with rainfall greater than 30 cm pm. The ranges correspond to those stated in the preceding paragraph.

TABLE 1

Code for Rainfall Data

Symbol	Monthly rainfall cm pm
A+	Greater than 30
B	20-30
C	10-20
D*	5-10
E*	Less than 5

+An examination of monthly rainfall in the country shows that except for areas in the west coast and some hill stations in extreme north-east, normal monthly rainfall seldom exceeds 40 cm.

*In distributions containing ranges of rainfall covered by A or B termed briefly as A & B types amounts less than 10 cm are not so significant and their frequency is generally small. To reduce the number of combinations, D is omitted in A or B type distributions; instead E is used to denote less than 10 cm pm. Thus B_2E_2 would denote two months of 20-30 cm pm and two months less than 10 cm pm rainfall.

The southwest monsoon months of June to September being the principal rainy season dominate the rainfall distributions of the country. To indicate the season's importance, monthly rainfall distribution during June to September is shown in brackets in the annual pattern. To the right of the bracket is the distribution for the post-monsoon months, namely, October to January and to the left that for the pre-monsoon months namely, February to May. In order to explain how such a coded rainfall distribution written in symbols with numerical subscripts has to be interpreted, a hypothetical example may be considered. $D_1 E_3 (A_2 B_1 C_1) C_1 D_3$, in which for each of the three periods, the symbols are in order of decreasing rainfall which is not necessarily the calendar sequence, can be explained as under :

(i) D_1E_3 represents the period February to May in which one month's rainfall (usually May) is in the range of 5-10 cm and the remaining three months get less than 5 cm pm.

(ii) $A_2 B_1 C_1$ represents the period June to September, in which two months (usually July and August) get more than 30 cm pm rainfall, one month (September) gets 20-30 cm and the remaining month, i.e. June gets 10-20 cm.

(iii) $C_1 D_3$ represents the period October to January in which October gets 10-20 cm rainfall and the rest 5-10 cm pm.

Boundaries of Rainfall Zones

2.5 Since differences in monthly, seasonal and annual rainfall are not large within short distances, linear interpolation of rainfall data is permissible. Rainfall data being point measurements, isolines for the same or nearly the same type of distribution of monthly rainfall can, therefore, be drawn. These isolines may not necessarily follow the boundaries of

taluks which are taken to be unit of area in this study and hence for delineation of boundaries the following procedure has been adopted :

(i) Where variations are small, isolines follow the taluk boundaries;

(ii) where variations are large, isolines delineate the zone boundaries; and

(iii) any taluk, more than three quarters of which lies outside of a zone is not considered a part of that zone.

2.6 If an identical distribution is observed over two or more adjacent taluks a pattern is said to have evolved and the area covered by it is distinguished as a zone and indicated suitably by a Roman numeral. Rainfall patterns have been identified for the whole country using the methodology described above. The data used for the analysis are the monthly normals of rainfall (1901 to 1950)[1] and the patterns and zones are depicted on all-India map which forms part of Chapter 14 on Rainfall and Cropping Patterns of the Commission's Report.

Cropping Patterns

2.7 The basic data for the study of cropping patterns of the country are the area under different crops in each of the taluks. A large number of crops are grown in a taluk but most of them occupy small areas, often less than one per cent of the total cropped areas of the taluk. With a view to limiting the number of crops constituting a pattern only those crops are considered which individually occupy 10 per cent or more of the gross cropped area of the taluk. In this process, several crops have to be excluded, even though they may be otherwise important. The minimum limit has been fixed at 70 per cent, so that the number of crops, which together cover at least 70 per cent of the gross cropped area, and in which none occupies less than 10 per cent, is not large. Trial computations have shown that in such distributions any crop occupying more than 10 per cent area is rarely omitted and the number of crops hardly exceeds five. When the same distribution holds good for two or more adjacent taluks, a pattern is obtained.

2.8 As in the case of rainfall, percentage area coverage by crops is expressed by means of numerical subscripts affixed to crop symbols shown in Table 2. The list of crops given below is comprehensive and will hold good for all the States.

TABLE 2
Crop Symbols and Area Intervals

Crop	Symbol
1 rice	Pd
2 Wheat	W
3 jowar (kharif)	Jk
4 jowar (rabi)	Jr
5 bajra	B
6 maize	M
7 ragi	R
8 small millets	Mt
9 barley	Ba

TABLE 2 (Contd.)

Crop	Symbol
10 Oats	Oa
11 gram	G
12 pigeonpea (tur)	T
13 pulses other than pigeonpea and gram	Pu
14 groundnut	Gn
15 oilseeds other than groundnut	O
16 cotton	C
17 jute	Ju
18 other fibres	Fb
19 sugarcane	S
20 potato	Pt
21 vegetables	V
22 fruits	Fr
23 tapioca	Ta
24 plantations	L
25 fodder	F
26 chillies	Ch
27 tobacco	To

Area interval (percent)	Subscript
70 or more	1
50-70	2
30-50	3
10-30	4
less than 10	5

The crop code contains the crop symbols and the appropriate subscript. In writing crop distribution, the first crop has always the highest area but the rest may not necessarily follow the order of decreasing areas. For example, crop distribution, C_3 Jr_4 Mt_4, means that cotton area is 30-50 per cent, and jowar rabi and millets each occupies 10-30 per cent of the gross cropped area, the total being 70 per cent or more. Two or more taluks having the same distribution of crops constitute a pattern. Cropping patterns so derived have been indicated on maps of 1 : 1 million size.

Relative Yield Index of Crops

2.9 Besides the absolute figures the yield of a crop has also been expressed as per cent of all-India average which is called Relative Yield Index (RYI). Relative Yield Index values have been computed for the principal crops on the basis of (1968-69 to 1970-71) data available in the records of the Directorate of Economics and Statistics, Ministry of Agriculture and Irrigation.

Livestock Patterns

2.10 The livestock patterns are relevant only insofar as these are related to production of fodder and feeds. As talukwise data were not available for the livestock Census, 1972, those of 1966 Census as published by the States have been used. The animals considered for livestock analysis are shown in Table 3 together with their symbols.

[1] Memoirs of India Meteorological Department, Volume XXXI, part 3, 1962.

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TABLE 3
Livestock Symbols

Category	Symbol
cattle:	
male (over 3 years)	Cm
female (over 3 years)	Cf
young stock (under 3 years)	Cy
buffaloes :	
male (over 3 years)	Bm
female (over 3 years)	Bf
young stock (under 3 years)	By
sheep	S
goats	G
horses, mules and ponies	H
donkeys	D
camels	Ca
pigs	P

The livestock patterns are expressed in coded form in the same manner as the cropping patterns.

Soils

2.11 Soil data on a taluk basis are not available for all the areas of the country. As such, soils have been discussed in a general manner using the traditional nomenclature in describing their characteristics.

Other Data

2.12 The sources of other data featuring in the study are given below :

item	source
taluk area	States' Census Reports 1971 or from the data furnished by the States in their land-use returns.

item	source
orography	maps of the Surveys of India and National Atlas Organisation
temperature	Climatological Tables of Observatories in India, India Meteorological Department, 1931-1960 normals
evapotranspiration	Scientific Report No. 136 of the India Meteorological Department, 1971
human population	Census of India, 1971
irrigation and land use statistics	basic data pertaining to land utilisation statistics obtained from the States and refer mostly to 1969-70

Presentation of Information

2.13 The tables required for following the text are given in the text itself at appropriate places, whereas the basic data are appended as follows :

APPENDIX 1	Districtwise Livestock Population—1966 (arranged according to State rainfall zones)
APPENDIX 2	Districtwise Information on Rainfall, Rainy days and Cropping Patterns.
APPENDIX 3	Districtwise area under Principal Crops (per cent of Gross Cropped Area)

2.14 Rainfall, cropping and livestock patterns of each State are indicated on maps in the 1 : 1 million scale and given in Appendices 4, 5 and 6 respectively. In the case of rainfall patterns, the zonal numbers in State maps have been given in Roman numerals and their all-India equivalents as used in Chapter 14 of the Commission's Report have been shown in three digit Arabic numerals within brackets.

3 GENERAL FEATURES

Area

3.1 The State has 16 districts covering an area of 87,853 sq km and includes the city district of Calcutta with an area of 104 sq km. The areas of other 15 districts vary widely from about 1,474 sq km (Howrah) to 13,724 and 13,796 sq km of Midnapore and 24 Parganas respectively. The distribution of district areas is given below :

area '000 sq km	1-2	2-3	3-4	4-5	5-6	6-7	7-8	13-14
number of districts	1	—	5	1	2	3	1	2

Population

3.2 It is one of the most densely populated States in the country with a total population of 44·3 million.

The population density works out to 504 per sq km. Districtwise population and population density are given in Table 4 . The city districts of Calcutta (city), 24 Parganas, Howrah, Hooghly, Burdwan, Nadia, and Murshidabad have a very high population density, the density in Howrah being 1,640, in Hooghly 913, and the hill district of Darjeeling of 254. The density distribution is as follows :

density per sq km	200-300	300-400	400-500	500-600
number of districts	4	2	3	3
	600-800	800-1000	1640	30276
	1	1	1	1

Seventy five per cent of population is rural.

TABLE 4

Districtwise Population, Area and Density

District	Population million	Area sq km	Density per sq km
Darjeeling	0·8	3075	254
Jalpaiguri .	1·8	6245	280
Cooch Behar	1·4	3386	418
West Dinajpur	1·9	5206	357
Malda	1·6	3713	434
Murshidabad	2·9	5341	550
Nadia .	2·2	3926	568
24 Parganas	8·4	13796	612
Howrah	2·4	1474	1640
Calcutta	3·1	104	30276
Hooghly	2·9	3145	913
Burdwan	3·9	7028	557
Birbhum	1·8	4550	390
Bankura	2·0	6881	295
Midnapore	5·5	13724	401
Purulia	1·6	6259	256
State	44·3	87853	504

Land Use

3.3 Forests and land not available for cultivation account for 25 per cent of the area of the State and net sown area is 63 per cent. The cropping intensity in 121 per cent. Forests are confined to the southern, southwestern and northern districts. Darjeeling has nearly 40 per cent of the reporting area under forests followed by 24 Parganas and Cooch Behar (25-30 per cent), and Purulia, Bankura and Midnapore (10 to 20 per cent). Elsewhere, forest area is negligible. Land not available for cultivation is mostly 10 to 20 per cent of the reporting area but in Hooghly and Darjeeling it is of the order of 23-25 per cent. Uncultivated land is 5 per cent in general excepting Bankura where it is 11 per cent and in Purulia 22 per cent. Current fallows are negligible except for 7 to 10 per cent in southwest districts and in Jalpaiguri. The net sown area varies from 31 to over 80 per cent of the reporting area. For example in

24 Parganas, Jalpaiguri and Purulia it is 45 to 50 per cent, Bankura 55 per cent, Howrah and Midnapore 65 per cent, Burdwan about 70 per cent, and the remaining six districts from Nadia to West Dinajpur and Cooch Behar have 80 per cent. Fifty per cent of the net sown area of Nadia and Murshidabad is sown more than once followed by 25 to 35 per cent in Hooghly, West Dinajpur and Cooch Behar, 8 per cent in the southwestern districts and 15 to 25 per cent in the remaining districts.

Soils

3.4 Recent alluvial soils form the main group in the eastern districts from 24 Parganas to Nadia, West Dinajpur and Cooch Behar. Half of Midnapore and central part of Birbhum has laterite soils Red sandy soils are in Bankura, Purulia and western parts of Burdwan and Birbhum. Jalpaiguri and central part of Darjeeling have Terai soils while red and yellow soils dominate Murshidabad and Darjeeling and Malda and adjoining parts of West Dinajpur have red loamy soils.

Irrigation

3.5 The net irrigated area in 1967-68 was 1·49 million ha (27 per cent of net sown area). Sixty four per cent of the area was irrigated by canals, 20 per cent by tanks and 14 per cent from other sources (excluding wells). Well irrigation was negligible. The extent of irrigation in districts varied widely. Hooghly, Burdwan and Birbhum have 50, 60 and 70 per cent irrigated area. Midnapore and Bankura have 35 to 40 per cent and Purulia, Hooghly, Murshidabad, Jalpaiguri and Darjeeling 20 to 25 per cent area under irrigation. In the remaining districts, irrigation is negligible. The gross irrigated area was 1·54 million ha (23 per cent of gross cropped area). Eighty-eight per cent of gross irrigation area was under rice and 2 per cent under wheat.

Rainfall

3.6 The monthly and annual rainfall data are given in Table 5. The annual rainfall varies widely from 150 to 160 cm in the southern districts, 130 to 140 cm in the central districts, 150 to 160 cm in Malda and West Dinajpur, 300 to 400 cm in the northern districts and 200 to 300 cm in the hill districts.

TABLE 5

Monthly and Annual Rainfall

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Gangetic West Bengal													
R (cm)	1	3	3	4	11	24	32	32	21	11	2	—	144
n	1	2	2	3	6	11	15	15	11	5	1	—	272
CV	117	111	108	108	73	41	28	23	26	69	149	200	13
Sub Himalayan* West Bengal													
R (cm)	1	2	4	12	33	68	68	57	50	16	1	—	313
n	1	2	2	6	13	18	18	18	14	6	1	—	100
CV	118	85	86	58	27	24	27	28	27	67	184	—	12

(*excluding hill areas)

R = rainfall in cm

n = number of rainy days

CV = Co-efficient of Variation

Rainfall Variability

3.7 During the period January-May, coefficient of variation (CV) exceeds 100 except in northern districts where it is between 80 and 100. CV ranges from 23 to 41 during the months of June to September. CV during October-December ranges from 69 to 200.

Temperature

3.8 Normals of maximum, minimum and mean daily temperatures are given in Table 6 to 8. January is the coldest month of the year with minimum temperatures of 10° to 13°C Except for coastal area where they are of the order of 15°C. June to September monthly variations are less than a degree, averages being 25°-26°C. The annual averages are 20°-21°C except in near coast where they are 22° to 24°C. From a general average level of 24-26°C in January, maximum temperature rises rapidly in many areas experiencing 33-35°C by March. April to June are the hottest months of the year. January, the coldest month of the year has mean daily temperatures ranging between 19 to 21°C. By April these rise rapidly to 30 to 32°C. May is the hottest with mean daily temperatures between 30 to 33°C. June values are slightly less being between 29 to 31°C. Temperatures decrease in December. The annual averages of mean daily temperature are between 25 to 27°C.

Potential Evapotranspiration (PE)

3.9 December and January have the lowest PE of 5-6 cm north of Murshidabad and 7-8 cm south of it. March PE in the Southern districts is 14-15 cm and 12-13 cm in the north. April PE is 15 to 18 cm. May PE is highest. In the coastal area PE is about 25 cm and in the interior 20 cm up to Malda and is 15 cm in the extreme northern districts. May rainfall is 11 cm except in the north where it is 30 cm or higher. June PE is 11-12 cm in the northern areas and 13-15 cm elsewhere. July PE is 11 to 13 cm which is about a third of the rainfall except in north where it is less than a fifth. PE in August is similar. The annual PE is 160 cm in the Coastal belt, 140 to 150 cm in the southern districts, 130-140 cm in Nadia to Murshidabad and 120-125 cm elsewhere.

Climatic Classification

3.10 Moisture index calculated using water balance approach is positive in the State except in the western districts of Burdwan, Purulia and neighbourhood when it is slightly negative. The climatic classification is 'Dry Sub-Humid' in the districts of Purulia, Burdwan and neighbourhood. In the rest of the State, it is moist Sub-humid.

TABLE 6
Normals of Daily Maximum Temperature (°C)

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Asansol	25·7	28·3	34·2	38·5	39·1	36·1	32·0	31·6	31·9	31·4	29·0	26·2	32·0
Baghdogra	24·0	26·6	30·3	33·2	32·0	31·3	31·0	31·7	31·7	30·5	28·5	26·0	29·7
Berhampore	25·7	28·4	34·1	37·6	37·1	34·5	32·5	32·3	32·8	32·2	29·4	26·4	31·9
Burdwan	26·2	28·6	34·1	37·5	37·2	34·8	32·0	31·9	32·2	31·4	28·7	26·2	31·7
Calcutta (Dum Dum)	26·4	29·0	33·8	36·0	35·7	33·8	31·8	31·8	32·0	31·4	29·0	26·5	31·4
Calcutta	26·8	29·5	34·3	36·3	35·8	34·1	32·0	32·0	32·3	31·8	29·5	27·0	31·8
Contai	26·6	29·4	32·5	33·9	33·6	32·5	30·8	31·2	31·1	31·1	29·2	27·1	30·8
Darjeeling	9·3	11·1	14·8	18·0	18·6	19·3	19·8	19·8	19·9	18·6	15·3	11·9	16·4
Jalpaiguri	23·4	25·2	29·6	31·6	30·9	30·6	30·6	30·8	30·7	30·0	27·7	25·0	28·8
Kalimpong	15·5	16·7	20·6	23·1	24·1	24·4	24·1	24·3	24·1	23·3	20·0	17·3	21·5
Krishnanagar	26·8	29·6	35·0	37·9	37·0	34·3	32·3	32·4	32·9	32·6	30·2	27·4	32·4
Malda	24·2	26·8	32·6	36·0	35·6	33·6	31·8	31·6	31·7	30·9	27·6	25·1	30·6
Midnapore	26·9	29·6	35·1	38·4	38·2	35·3	31·9	31·9	32·1	31·4	29·0	26·7	32·2
Purulia	25·4	29·0	34·1	39·0	40·1	36·3	31·7	31·4	31·4	30·9	28·1	26·0	32·0
Sagar Island	25·0	26·8	30·0	31·3	32·1	31·7	30·3	30·2	30·5	30·0	27·9	25·3	29·3
Cooch Behar	24·0	26·8	30·5	32·6	31·5	31·0	31·3	31·9	32·0	31·0	28·3	25·8	29·7

TABLE 7
Normals Of Daily Minimum Temperature (°C)

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Asansol	12·2	14·7	19·6	23·8	26·3	26·4	25·6	25·5	25·3	22·2	16·1	12·4	20·8
Baghdogra	8·7	10·9	15·3	19·6	22·9	24·0	24·7	24·7	23·9	20·5	14·1	9·9	18·3
Berhampor	11·8	13·7	18·4	23·1	24·7	26·0	26·0	26·1	25·8	23·3	17·4	13·1	20·8
Burdwan	12·7	14·9	20·1	24·3	25·8	26·1	25·8	25·8	25·7	23·7	17·8	13·6	21·4
Calcutta (Dum Dum)	13·3	15·1	20·4	24·3	26·0	26·2	26·0	26·0	25·9	23·6	17·6	13·0	21·4
Calcutta	13·6	16·5	21·5	25·0	26·5	26·7	26·3	26·3	26·1	23·9	18·4	14·2	22·1
Contai	14·5	17·6	22·3	25·9	27·3	26·5	26·3	26·2	25·9	24·7	18·8	14·8	22·6
Darjeeling	3·0	4·3	7·7	10·8	12·9	14·7	15·4	15·4	14·6	11·5	7·4	4·4	10·2
Jalpaiguri	10·8	12·7	16·4	20·4	22·9	24·3	25·0	24·9	24·4	21·4	16·2	12·1	19·3
Kalimpong	7·8	9·1	12·2	15·0	17·3	18·9	19·2	19·3	18·8	16·1	11·6	8·8	14·5
Krishnanagar	11·1	13·7	18·8	23·4	25·2	26·0	25·6	25·7	25·5	23·0	16·7	12·1	20·6
Malda	10·8	12·8	17·4	22·1	24·7	24·8	26·2	26·2	25·8	22·8	15·7	12·2	20·2
Midnapore	13·1	15·9	20·8	24·6	26·3	26·5	25·8	25·8	25·6	23·0	17·0	13·3	21·5
Purulia	12·8	15·4	20·0	24·7	26·9	26·1	24·9	24·9	24·3	22·2	16·6	13·3	21·0
Sagar Island	15·8	18·8	23·9	26·5	27·3	27·4	26·7	26·7	26·6	25·1	20·3	16·4	23·5
Cooch Behar	10·1	12·3	16·6	20·3	22·8	24·3	25·4	25·9	25·1	22·1	15·5	12·7	19·4

TABLE 8

Normals of Daily Mean Temperature (°C)

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Asansol	19·0	21·5	26·9	31·2	32·7	31·3	28·8	28·6	28·6	26·8	22·6	19·3	26·5
Baghdogra	16·4	18·8	22·8	26·4	27·5	27·7	27·9	28·2	27·8	25·5	21·3	18·0	24·0
Barhampore	18·8	21·1	26·3	30·4	30·9	30·3	29·3	29·2	29·3	27·8	23·4	19·8	26·4
Burdwan	19·5	21·8	27·1	30·9	31·5	30·5	28·9	28·9	29·0	27·6	23·3	19·9	26·6
Calcutta (Dum Dum)	19·4	22·1	27·1	30·2	30·9	30·0	28·9	28·9	29·0	27·5	23·3	19·8	26·4
Calcutta	20·2	23·0	27·9	30·7	31·2	30·4	29·2	29·2	29·2	27·9	24·0	20·6	27·0
Contai	20·6	23·5	27·4	29·9	30·5	29·5	28·6	28·7	28·5	27·9	24·0	21·0	26·7
Darjeeling	6·2	7·7	11·3	14·4	15·8	17·0	17·6	17·6	17·3	15·1	11·4	8·2	13·3
Jalpaiguri	17·1	19·0	23·0	26·0	26·9	27·5	27·8	27·9	27·6	25·7	22·0	18·6	24·1
Kalimpong	11·7	12·9	16·4	19·1	20·7	21·7	21·7	21·8	21·5	19·7	15·8	13·1	18·0
Krishnanagar	19·0	21·7	26·9	30·7	31·1	30·2	29·0	29·1	29·2	27·8	23·5	19·8	26·5
Malda	17·5	19·8	25·0	29·1	30·2	29·7	29·0	28·9	28·8	26·9	21·7	18·7	25·5
Midnapore	20·0	22·8	28·0	31·5	32·3	30·9	28·9	28·9	28·9	27·2	23·0	20·0	26·9
Purulia	19·1	22·2	27·1	31·9	33·5	31·2	28·3	28·2	27·9	26·6	22·4	19·7	26·5
Sagar Island	20·4	22·8	27·0	28·9	29·7	29·6	28·5	28·5	28·6	27·6	24·1	20·9	26·4

TABLE 9

Normal Monthly and Annual Potential Evapotranspiration (PE)   (mm)

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
SUB-HIMALAYAN WEST BENGAL													
Baghdogra	59·2	72·6	119	155·2	169·1	112·6	106·3	105·1	100·2	95·6	67·7	49·7	1213·6
Jalpaiguri	55·2	74·3	125·7	151·8	144·9	123·7	117·5	118·2	105·2	105·2	73·7	53·9	1250·0
Cooch Behar	53·5	76·7	120·1	151·8	137·9	108·9	107·0	110·4	102·9	103·2	73·0	54·3	1200·3
Malda	63·2	83·7	139·3	173·7	187·6	128·8	118·2	110·3	107·0	112·3	77·3	61·2	1363·0
GANGETIC WEST BENGAL													
Barhampore	63·7	82·3	133·5	164·7	185·5	126·9	110·6	108·3	104·2	109·5	81·6	61·8	1333·0
Asansol	77·4	98·2	155·2	187·5	207·6	146·6	111·7	104·2	105·3	112·8	88·5	72·5	1458·2
Krishnanagar	67·4	87·7	144·0	177·5	203·7	126·8	110·8	107·3	102·9	112·7	84·1	64·3	1389·9
Purulia	72·3	94·7	142·5	175·2	196·3	145·5	108·2	102·5	102·2	111·8	85·6	67·6	1405·1
Burdwan	71·8	89·6	146·6	177·5	202·9	146·2	129·1	124·5	115·1	117·9	86·9	67·3	1476·0
Calcutta (Dum Dum)	75·1	94·5	153·1	180·7	224·4	129·4	116·4	110·4	107·0	112·0	88·2	69·7	1461·3
Calcutta	75·5	95·7	148·1	169·8	171·4	125·9	109·1	106·1	102·8	112·1	89·0	71·0	1463·8
Midnapore	78·2	97·8	153·1	184·2	206·5	139·2	114·8	108·5	108·2	112·9	87·3	72·6	1463·8
Contai	82·3	108·2	158·4	182·7	243·8	140·7	126·2	123·5	115·3	120·4	94·2	77·0	1573·1
Sagar Island	91·5	109·0	163·0	176·9	262·8	142·6	131·8	126·6	117·5	119·0	102·8	88·3	1632·5

4 RAINFALL ZONES, THEIR CROPPING AND LIVESTOCK PATTERNS

4.1 In the absence of basic data at taluk level, district has been adopted as the unit of area for purposes of formation of rainfall zones and study of cropping patterns and related factors. The State is divided into 6 rainfall Zones. These are indicated below together with the number of districts and the approximate area.

Rainfall Zone No.	Rainfall pattern	Number of districts with total approximate area (sq km)
I	$D_1E_3(A_2B_1C_1)D_1E_3$	2 (13,140)
II	$C_1E_3(B_3C_1)D_1E_3$	4 (20,845)
III	$C_1-E_3(A_2B_2)C_1-E_3$	2 (8,919)
IV	$C_1D_1E_2(A_2B_2)C_1E_3$	5 (32,243)
V	$B_1C_1E_2(A_4)C_1E_3$	1 (3075)
VI	$A_1C_1E_2(A_4)C_1E_3$	2 (9631)

Rainfall Zone I—D_1 $E_3(A_2$ B_1 $C_1)$ D_1 E_3

4.2 The districts included in the zone are Bankura and Purulia with a total area of 13,140 sq km. The total population of the zone is 3·6 million and its population density between 250 to 300 per sq km.

4.3 Forests account for 12 to 20 per cent of the reporting area and current fallows and other uncultivated land are substantial with 19 per cent in Bankura and 29 per cent in Purulia. This leaves 45 per cent in Purulia and 55 per cent in Bankura as net sown area. The soils are mostly red sandy.

4.4 The annual average rainfall of the zone is 135 cm July and August are the rainiest months together getting 63 to 68 cm (about 50 per cent of annual precipitation). June and September receive 20 cm per month rainfall followed by October (9 cm) and May (6 to 9 cm).

4.5 Paddy is the main crop with 80 to 90 per cent of cropped area. In Purulia pulses account for 9 per cent of the cropped area. The cropping pattern is : Pd_1

4.6 The Relative Yield Index of rice in Purulia and Bankura are 87 and 128 respectively. Rainfall distribution and soils are practically the same in both the districts. Though Purulia has more irrigated area the yields are considerably lower. Rainfall distribution is not unsatisfactory.

4.7 In Bankura, goats have the highest percentage (28 per cent) with pattern G_4 Cm_4 Cf_4. Male cattle are 45 per cent in Purulia but goats only 20 per cent; the pattern is : Cm_3 G_4 Cf_4.

Rainfall Zone II—C_1 E_3 (B_3 C_1) D_1 E_3

4.8 Four districts Nadia, Murshidabad, Burdwan and Birbhum are included in the zone and their total area is 20,845 sq km (24 per cent of the area of the State). Population density in the zone is high—390 per sq km in Birbhum and 550 to 570 in the other three districts.

4.9 Forests are negligible and lands not available for cultivation 15 to 20 per cent of the total reporting area, thus leaving net sown area of 70 to 80 per cent.

4.10 Soils in the zone vary. Nadia and southern portion of Burdwan have recent alluvium and the rest of Burdwan district has mostly red sandy soils. Birbhum has lateritic soils in its western half which extend to west Murshidabad also. Rest of the zone has red and yellow soils.

4.11 The annual rainfall in the zone varies between 130 and 135 cm. Rainfall during July and August is 25 to 30 cm pm and about 20 cm in September.

4.12 Burdwan and Birbhum have 75 to 85 per cent of gross cropped area under paddy. 10 per cent of Birbhum area is underwheat. The cropping pattern for these two districts is : Pd_1

Nadia and Murshidabad have 45 per cent paddy, 23-29 per cent pulses and 11-13 per cent jute. The pattern for these two districts is : Pd_3 Pu_4 Ju_4

4.13 Rice yield in Nadia and Murshidabad are around all-India level, their Relative Yield Index being 91 and 108 respectively though the crop is practically unirrigated. Burdwan and Birbhum crops are 60 to 70 per cent irrigated and the yields are 44 per cent higher than all-India. Jute yields are the same as of all-India.

4.14 In Burdwan female cattle predominate. In the rest of the zone goats are the most important. Nadia has 34 per cent goats and its pattern begins with G_3. The patterns are :

Nadia	G_3 Cm_4 Cf_4 Cy_4
Birbhum, Murshidabad	G_4 Cm_4 Cf_4 Cy_4
Burdwan	Cf_4 G_4 Cy_4 Cy_4

Rainfall Zone III—$C_1E_3(A_2B_2)C_1E_3$

4.15 Malda and West Dinajpur districts are in this zone and their total area is 8,919 sq km. The population density average 400 per sq km.

4.16 Net sown area is 83 per cent of the reporting area with practically no forests and land not available for cultivation is 10 per cent.

4.17 Malda and adjoining parts of West Dinajpur have red loamy soils; the rest has recent alluvial soils.

4.18 Malda annual average rainfall is 154 cm and that of West Dinajpur 163 cm. June and September get 27 to 30 cm pm rainfall followed by May (12 to 14 cm) and October (11-12 cm). This is a zone of good rainfall extending from May to October.

4.19 Area of paddy in West Dinajpur is 455,000 ha or 70 per cent of cropped area and its cropping pattern Pd_1. Paddy area in Malda is 50 percent 213,000 ha) and that of pulses 22 per cent. The cropping pattern is : Pd_3 Pu_4.

4.20 The Relative Yield Index values of rice in West Dinajpur and Malda are 89 and 83 respectively. Rainfall is adequate for rice crop and the yields are of the same order, but lower than all-India.

4.21 Male cattle are comparatively larger in number in Malda and goats in West Dinajpur. The livestock patterns are :

Malda	Cm_3 G_4 Cf_4 Cy_4
West Dinajpur	G_4 Cm_4 Cf_4 Cy_4

Rainfall Zone IV—$C_1D_1E_2(A_2 B_2)$ C_1E_3

4.22 Five southern districts of 24 Parganas, Hooghly, Howrah, Midnapore and Calcutta are included in the zone. Howrah and Midnapore districts have the largest area of 13,800 sq km each. The area of the zone is 32,243 sq km (36 per cent of the area of the State). It is a densely populated area with a total population of 22 million.

4.23 Forests occupy 25 per cent of reporting area in 24 Parganas followed by Midnapore 11 per cent and negligible elsewhere. Land not available for cultivation is 11 per cent in Midnapore and 20-25 per cent in the rest of the zone. Net sown area varies from 46 per cent in 24 Parganas, 63 per cent in Midnapore and Howrah to 76 per cent in Hooghly.

4.24 Soils are mainly recent alluvium or deltaic except in most of Midnapore, which is covered by laterite and red and yellow soils.

4.25 This is a zone of good rainfall. July and August rainfall is more than 30 cm pm followed by June (25 to 30 cm) and September (22-23 cm) having a rainy season of more than 6 months and the annual rainfall of 155 to 165 cm.

4.26 Paddy is main crop of the zone occupying more than 75 per cent of gross cropped area. The cropping pattern is Pd_1. Hooghly has 13 per cent are under jute.

4.27 Relative Yield Index values of rice crop are 102, 112, 120 and 140 respectively in 24 Parganas, Midnapore, Howrah and Hooghly. The rice crop in 24 Parganas is unirrigated but its yield is close to all-India average. In Hooghly 50 per cent area is

irrigated and the yield rises by 40 per cent. Rainfall distribution is generally adequate for rice crop in the monsoon season. Relative Yield Index values of jute in Hooghly and Howrah are 147.

4.28 Goats and cattle together constitute 95 per cent of the total livestock population. The livestock patterns are :

Hooghly and Howrah	G_4 Cm_4 Cf_4 Cy_4
24 Parganas and Midnapore	Cm_4 G_4 Cf_4 Cy_4

Rainfall Zone V—$B_1C_1E_2(A_4)C_1E_3$

4.29 Only Darjeeling district constitutes the zone. Being a hilly district, there are significant variations in elevation in different areas. The area of the district is 3,075 sq km. Its total population is 8 lakhs with a population density of 254 per sq km.

4.30 Nearly 40 per cent land is under forests 30 per cent is not available for cultivation and the remaining 30 per cent comprises net sown area.

4.31 The zone has mainly brown hilly soils with a pocket of Terai soils.

4.32 Annual rainfall in the zone is 300 cm. Some of the areas like Mongpore and Kursang receive 80 to 100 cm rainfall in July, the month with maximum precipitation. The month from April to October get more than 10 cm pm rainfall.

4.33 Paddy occupies only one-third of the reporting area followed by maize and tea (25 per cent each) and ragi (5 per cent). The cropping pattern of the district is : Pd_3 L_4 M_4.

4.34 Yields of rice and jute are around the all-India level. Potato yield is low, being half of all-India average. The low yield may be attributed to the prevalence of disease in Darjeeling hills and neighbouring areas.

4.35 Goats are nearly 30 per cent of livestock population followed by 20-25 per cent each of female and young stock of cattle and 16 per cent of male cattle. The pattern is :

G_4 Cm_4 Cf_4 Cy_4

Rainfall Zone VI—$A_1C_1E_2(A_4)$ C_1E_3

4.36 Cooch-Behar and Jalpaiguri districts are included in the zone. Their total area is 9,631 sq km. The total population of the zone is 3·2 million and population density works out to 418 in Cooch Behar and 280 in Jalpaiguri.

4.37 Net sown area in Jalpaiguri district is 50 per cent of the reporting area. The remaining area consists of forests (26 per cent) and land not available for cultivation (22 per cent). In Cooch-Behar there are no forests and land not available for cultivation is about 15 per cent. This leaves the net sown area of 83 per cent of the reporting area.

4.38 Soils are terai type in Jalpaiguri and recent alluvium in Cooch-Behar. These soils are acidic.

4.39 Rainfall is heavy in the zone exceeding 300 cm annually. Annual average rainfall in Jalpaiguri is 394 cm and of Cooch-Behar 320 cm. Average rainfall of Kumargram in Jalpaiguri district is 420 cm. Month of maximum rainfall is July in Jalpaiguri and June in Cooch-Behar; the average of these months being between 65 and 90 cm. Even April rainfall is 13 to 16 cm. This is a zone of good and heavy rainfall.

4.40 Area under paddy is 70 per cent of gross cropped area and that of jute 12 per cent of the total. Tea occupies 16 per cent area in Jalpaiguri. The cropping pattern of the zone is : Pd_1.

4.41 Yield of rice is close to all-India average. Autumn crop yields are low and to some extent these have depressed the average yield of rice. Rainfall, being more than 30 cm pm for four consecutive months, is adequate for the rice crop. Jute yields are low in Cooch-Behar, being only 75 per cent of all-India level. In Jalpaiguri, however, the yield is of the order of all-India average. Potato yields in both these districts are only about 40 per cent of all-India. The low yield is attributed to the prevalence of wart disease in these areas.

4.42 In Cooch-Behar male cattle constitute 32 per cent of the total livestock population and female cattle, young stock of cattle and goats each 17 to 19 per cent. The pattern is : $Cm_3Cf_4G_4/Cy_4$. In Jalpaiguri, goats are larger in number and male cattle, female cattle and youngstock of cattle are each 21-22 per cent. The pattern is :

$G_4Cf_4Cy_4Cm_4$.

5 FUTURE CROPPING PATTERNS—SOME OBSERVATIONS

General

5.1 In the foregoing sections we have dealt with in detail the rainfall, cropping and livestock patterns which emerge from the existing information. We have also categorised the rainfall patterns into zones and discussed how the other patterns feature in those zones. Among other information that on soils, which plays an important role in determining cropping patterns, is lacking in such details as are wanted for this analysis. Data on orography and popula-

tion density have featured in this analysis but their exact role on cropping and livestock patterns could not be brought out owing to lack of detailed information. We are, however, convinced that studies and analysis indicated in the preceding sections are important for the guidance they may give in deciding cropping and livestock patterns vis a vis rainfall patterns. The greater the accuracy of the primary information and the more detailed such information is more useful the data would be in drawing up the most efficient cropping and livestock patterns in an

area or a zone. With this purpose in view the following procedures are suggested :

(i) Delineation of rainfall zones;

(ii) Identification of the existing cropping patterns;

(iii) Assessment of area needed for each crop and its ideal distribution.

(iv) Comparison of (iii) with (ii) in order to determine possible changes; and

(v) Consideration of other related factors like soil, irrigation facilities, density of population, livestock patterns and then arriving at the future cropping patterns.

5.2 The methods of delineating rainfall patterns or zones and cropping patterns have been fully discussed in Section 2. For the purpose of locating suitable areas for a crop, soil and topography of the land are important factors. The approximate area to be put under each crop will be decided by the demand for it not only at a State level but at the national level, either for internal consumption or for the purpose of export. The departments responsible for crop planning of the State should, therefore, be cognisant of the demand for a crop, so that production efforts are not rendered futile because of lack of demand and marketing. We have already discussed the part each of the factors mentioned in item (v) of para 5.1 is likely to play in deciding cropping patterns. For this purpose not only detailed data but also knowledge about the correlation between these factors and crop performance would be necessary. Knowledge gained, through long experience, by farmers would also be most helpful.

5.3 We may mention that the rainfall intervals which form the basis of identifying rainfall patterns are subject to minor modifications. Thus, the condition that 30 cm of rainfall for three consecutive months is good for paddy may not be rigorously adhered to. If the soil is favourable with a high water retention capacity or, what is more important, water management is efficient with an eye to economise water use, rainfall lower than 30 cm for three months may sustain a good crop of paddy.

5.4 The choice of a cropping pattern is not decided by the farmer only on technical grounds. He is also guided by the profitability of the crops or requirements for his household consumption. Farmers may not be inclined to accept a crop unless the necessary inputs and infrastructure are assured. Of all the inputs water is the most important as is made evident by the spread of groundnut in the country, sugarcane in Gujarat, maize and cotton in Karnataka and recently of wheat in West Bengal. These are excellent instances of the manner of introduction of new crops in the cropping patterns of a State or a region.

Some Observations pertaining to West Bengal

5.5 Paddy is the most important crop of the State. As a single crop it occupies more than 70 per cent of the area of the State in 12 out of 16 districts but the

rainfall pattern in the two districts of Burdwan and Birbhum is of the $B_3 C_1$ category in the rainy months of June to September. This type of rainfall is hardly conducive to good growth of paddy but the yields in these two districts are the highest in the State. This is because of irrigation support.

5.6 There are two other districts having the rainfall distribution in the category of $B_3 C_1$ in the monsoon months; these are Nadia and Murshidabad. Their yields are, however, much below those of Burdwan and Birbhum. Irrigation in these two districts is negligible when compared to Burdwan and Birbhum.

5.7 There is hardly any case for giving preference to paddy over many other less water requiring crops in the areas with a rainfall distribution of $B_3 C_1$ category and if the crop is made a success by resort to irrigation, it is to be accepted that it is at the cost of other crops.

5.8 As many as three crops of rice are being raised in West Bengal. For the reasons explained in Chapter 21 on Foodgrain Crops of the Report, the classification of rice crop according to its dates of sowings, as observed in different parts of the country, could be grouped into three categories, namely, (a) February to May sown crop, (b) June to September sown crop, and (c) October to January sown crop. The area occupied by the different rice crops and their performance according to the dates of sowings are indicated below :

	Per cent of State rice area	Yields as per cent of overall State rice yield
February-May sown crop	16	84
June-Sept. sown crop .	80	97
Oct-Jan. sown crop . .	4	217

5.9 It can be seen that June-September sown crop occupies the bulk of the rice area of the State and its performance equals about the overall State average. The February-May sown crop occupies about 16 per cent of the area but its yield is only about 80 per cent of the State average. The October-January sown crop occupies only 4 per cent of the rice area of the State but its performance is exceedingly good.

5.10 Cotton and wheat are proving a success as new crops in this State. Maize, soyabean, sunflower and many other leguminous grain and fodder crops should also be given attention. Owing to all these reasons, it should be seriously considered as to whether it is not advantageous to include various other crops in the cropping patterns in different parts of the State with a view to making best use of water resources available in the State and at the same time provide increased employment opportunities. Diversification appears to be possible and hence it is suggested that serious consideration should be given by the research scientists and planners.

APPENDIX 1

Districtwise Livestock Population- 1966

WEST BENGAL

District	Cattle			Buffaloes			Sheep	Goats	Horses & po- nies	Mules	Don- keys	Cancls	Pigs	Total live- stock
	m	f	ys	m	f	ys								
Rainfall Zone—I ..		..		..		..		..		..				
Bankura	333	441	367	21	28	21	90	522	—	—	—	—	24	1848
	(18)	(24)	(20)	(1)	(2)	(1)	(5)	(28)	(—)	(—)	(—)	(—)	(1)	
Purulia	573	211	84	63	11	7	72	258	—	—	—	—	6	1287
	(45)	(16)	(6)	(5)	(1)	(1)	(6)	(20)	(—)	(—)	(—)	(—)	(0·5)	
Rainfall Zone—II ..		..		..		..		..		..	*Rainfall Pattern—$C_1E_3(B_3C_1)D_1E_3$*				
Nadia	214	162	162	40	5	2	44	324	1	—	—	—	3	958
	(22)	(17)	(17)	(4)	(0·5)	(0·2)	(5)	(34)	(0·1)	(—)	(—)	(—)	(0·3)	
Murshida- bad	263	370	263	73	33	32	67	474	3	—	—	—	8	1586
	(17)	(23)	(17)	(5)	(2)	(2)	(4)	(30)	(0·2)	(—)	(—)	(—)	(0·5)	
Burdwan	261	474	362	69	18	7	54	409	1	—	—	—	8	1662
	(16)	(28)	(22)	(4)	(1)	(0·4)	(3)	(25)	(0·1)	(—)	(—)	(—)	(0·5)	
Birbhum	239	268	180	24	8	4	71	324	4	—	—	—	18	1140
	(21)	(24)	(16)	(2)	(1)	(0·4)	(6)	(28)	(0·4)	(—)	(—)	(—)	(1)	
Rainfall Zone—III ..		..		..		..		..		..	*Rainfall Pattern—$C_1E_3(A_2B_2)C_1E_3$*				
Malda	243	98	104	38	30	20	48	170	4	—	—	—	12	767
	(31)	(13)	(14)	(5)	(4)	(3)	(6)	(22)	(0·4)	(—)	(—)	(—)	(2)	
West Dinajpur	324	230	253	47	6	5	9	379	4	—	—	—	26	1283
	(25)	(18)	(20)	(4)	(0·5)	(0·4)	(1)	(30)	(0·3)	(—)	(—)	(—)	(2)	
Rainfall Zone—IV ..		..		..		..		..		..	*Rainfall Pattern $C_1D_1E_2(A_2B_2)C_1E_3$*				
24-Parganas	654	554	475	34	75	39	104	633	4	—	—	—	4	2578
	(25)	(22)	(18)	(1)	(3)	(2)	(4)	(25)	(0·2)	(—)	(—)	(—)	(0·2)	
Hooghly	239	226	182	5	8	8	5	272	1	—	—	—	2	948
	(25)	(24)	(19)	(0·5)	(1)	(1)	(0·5)	(29)	(0·1)	(—)	(—)	(—)	(0·2)	
Howrah	107	127	103	1	4	2	3	135	—	—	—	—	1	481
	(22)	(26)	(21)	(0·2)	(1)	(0·3)	(1)	(28)	(—)	(—)	(—)	(—)	(0·1)	
Midnapore	1018	649	584	47	31	23	49	532	—	—	—	—	13	2947
	(34)	(22)	(20)	(2)	(1)	(1)	(2)	(18)	(—)	(—)	(—)	(—)	(0·4)	
Calcutta							not available							
Rainfall Zone—V ..		..		..		..		..		..	*Rainfall Pattern—$B_1C_1E_2(A_4)C_1E_3$*				
Darjeeling	54	66	86	8	6	6	5	95	3	—	—	—	11	341
	(16)	(19)	(25)	(2)	(2)	(2)	(2)	(28)	(1)	(—)	(—)	(—)	(3)	
Rainfall Zone—VI ..		..		..		..		..		..	*Rainfall Pattern—$A_1C_1E_2(A_4)C_1E_3$*				
Cooch- Behar	236	138	133	33	24	26	10	128	1	—	—	—	3	732
	(32)	(19)	(18)	(5)	(3)	(4)	(1)	(17)	(0·1)	(—)	(—)	(—)	(0·4)	
Jalpaiguri	151	158	155	28	5	15	9	181	1	—	—	—	3	706
	(21)	(22)	(22)	(4)	(1)	(2)	(1)	(26)	(0·1)	(—)	(—)	(—)	(1)	

m = male

f = female

ys = youngstock

— = nil or negligible

Note : (i) Figures in brackets represent percentages to total livestock population.

(ii) Figures have been rounded of individually and may not total upto that given in the last column.

APPENDIX 2

Rainfall and Cropping Patterns

WEST BENGAL

Cropping pattern	District	Geo-graphi-cal area (sq km)	Elevation (masl) max	Elevation (masl) min	Annual Rainfall total (cm)	Annual Rainfall rd	mmr	mr	md	*Consecutive Months a	b	c
	Rainfall Zone—I .	..	..	..	..		..	*Rainfall Pattern—*D_1 E_3 $(A_2$ B_1 $C_1)D_1$ E_3			
Pd₁	Bankura	6881	448	40	132	68	7-8	64	31	6-4	103	51
Pd₁	Purulia	6259	677	222	136	71	7	68	31	6-4	110	54
	Rainfall Zone—II.	..	..	..	..		..	*Rainfall Pattern—*C_1 E_3 $(B_3$ $C_1)_1$ D_1 E_3			
Pd₃ Pu₄ Ju₄/G₄	Nadia	3926	17	9	131	75	8″	51	30	5-6	116	65
Pd₃Pu₄Ju /G₄	Murshidabad	5341	18	15	135	71	8-7″	56	30	5-6	123	63
Pd₁	Burdwan	7028	113	12	135	70	8-7″	58	30	5-5	113	57
Pd₁	Birbhum	4550	67	60	129	68	8″	60	30	5-5	110	56
	Rainfall Zone—III.	..	..	..	..		..	*Rainfall Pattern—*C_1 E_3 $(A_2$ $B_2)$ C_1 E_3			
Pd₃ Ju₄	Malda	3713	41	31	154	67	8-7	65	30	5-6	144	61
Pd₁	West-Dinajpur	5206	93	25	163	69	8-7	69	29	5-6	154	62
	Rainfall Zone—IV	..	..	..	..		..	*Rainfall Pattern—*C_1 D_1 E_2 $(A_2$ $B_2)$ C_1 E_3			
Pd₁	24 Parganas	13796	9	6	161	79	7-8	68	33	5-6	145	70
Pd₁	Hooghly	3145	16	8	152	75	8″	63	31	5-6	135	66
Pd₁	Howrah	1474	6	4	163	81	7-8	69	34	5-6	147	71
Pd₁	Midnapore	13724	132	3	154	74	7-8	66	31	5-6	139	65
	Calcutta	104			—not available—							
	Rainfall Zone—V .	..	..	..	..		..	*Rainfall Pattern—*B_1 C_1 E_2 (A_4) C_1 E_3			
Pd₃L₄M₄	Darjeeling	3075	33	23	299	116	7	137	43	4-7	289	108
	Rainfall Zone—VI	..	..	..	..		..	*Rainfall Pattern—*A_1 C_1 E_2 (A_4) C_1 E_3			
Pd₁	Cooch Behar	3386	66	34	320	102	6	141	37	4-7	313	97
Pd₁	Jalpaiguri	6245	89	76	394	114	7″	174	41	4-7	383	107

masl = metres above sea level

rd = rainy days

mmr = month of maximum rainfall

mr = total rainfall of mmr plus that of preceding or following month, whichever is higher, in cm.

md = number of rainy days of mmr plus that of preceding or following month, whichever has higher rainfall.

* Consecutive months with rainfall of more than 10 cm per month

a = Initial months with more than 10cm of rainfall and number of consecutive months with more than 10 cm/months, separated by hyphen.

b = Total rainfall of consecutive months in 'a', in cm.

c = Total number of rainy days of consecutive months in 'a'.

na = not available.

NOTE : Information on rainfall and rainy days are based on the Memoirs of India Metcrological Department, Vol. XXXI, Fail III as on 12th May, 1961.

APPENDIX 3

Districtwise Area under Principal Crops
WEST BENGAL

District	Gross cropped area (000 ha)	Pd	Jk	Jr	B	M	R	W	Ba	Mt	G	T	Pu	S	Gn	O	Mesta	Jute	Tea	Misc
Rainfall Zone—I																				
Bankura	417	382 (92)	—	—	1 (0.2)	4 (1)	—	—	—	—	—	—	9 (2)	2 (0.5)	4 (1)	—	—	— (—)	—	9 (2)
Purulia	312	260 (83)	—	—	0.1 (0.4)	1 (0.4)	—	—	—	2 (1)	1 (0.5)	—	21 (7)	—	4 (1)	3 (1)	—	0.4 (0.1)	—	7 (2)
Rainfall Zone—II																				
Nadia	511	217 (43)	—	—	—	26 (5)	—	3 (1)	—	—	68 (13)	14 (3)	67 (13)	7 (1)	26 (5)	11 (2)	66 (13)	— (—)	—	6 (1)
Murshidabad	647	291 (45)	—	—	4 (1)	57 (9)	—	16 (3)	0.4 (0.1)	—	42 (6)	11 (2)	97 (15)	9 (1)	30 (5)	6 (1)	73 (11)	0.4 (0.1)	—	10 (1)
Burdwan	563	472 (84)	—	—	0.4 (0.1)	17 (3)	—	7 (1)	—	—	10 (2)	4 (1)	23 (4)	4 (1)	5 (1)	2 (0.4)	11 (2)	— (0.1)	—	17 (3)
Birbhum	445	334 (75)	—	—	0.4	43 (10)	—	— (0.3)	—	—	2 (0.2)	1 (0.2)	32 (7)	4 (1)	6 (1)	0.2 (0.4)	—	0.2	—	12 (3)
Rainfall Zone—III																				
Malda	425	213 (50)	—	—	8 (0.2)	10 (2)	—	24 (6)	7 (2)	—	18 (4)	2 (0.4)	77 (18)	3 (1)	20 (5)	6 (2)	24 (6)	— (0.2)	—	10 (2)
West Dinajpur	646	455 (70)	—	—	— (0.1)	10 (2)	—	17 (3)	— (0.1)	—	3 (0.5)	2 (0.3)	32 (5)	2 (0.3)	27 (4)	14 (2)	67 (10)	— (0.2)	—	14 (2)
Calcutta	—	*not available*																		
Midnapur	1030	902 (88)	—	—	— (0.1)	8 (1)	—	—	— (0.1)	—	0.4 (—)	2	52 (5)	4 (0.3)	7	3	11 (1)	0.2	—	38 (4)
Howrah	120	94 (78)	—	—	—	4 (4)	—	0.4 (0.1)	—	—	— (0.4)	— (0.1)	6 (4)	— (0.4)	2	0.8	6	0.2	—	8 (8)
Hooghly	305	211 (69)	—	—	—	13 (4)	—	0.4 (0.1)	—	—	— (0.4)	—	13 (4)	— (0.2)	4	0.4	38 (13)	—	—	24 (8)
Rainfall Zone—IV																				
24-Parganas	836	637 (76)	—	—	0.4 (0.1)	9 (1)	—	1 (—)	—	12 (1)	— (0.1)	1 (0.1)	53 (6)	2 (0.2)	9 (1)	6 (1)	47 (6)	1 (—)	—	60 (7)
Rainfall Zone—V																				
Darjeeling	117	40 (34)	—	—	—	27 (23)	6 (5)	—	1	5 (2)	12 (1)	0.1 (0.1)	2 (1)	0.1	20 (5)	6 (2)	24 (7)	3	28	8 (7)
Rainfall Zone—VI																				
Cooch-Behar	357	261 (73)	—	—	0.2	— (1)	0.4 (0.3)	0.4	—	— (0.1)	— (0.4)	0.2 (0.1)	12 (3)	— (0.1)	7 (2)	0.4	48 (13)	—	24	17 (5)
Jalpaiguri	376	253 (67)	—	—	2	0.1	— (0.5)	— (0.2)	—	—	— (0.2)	— (0.1)	4 (1)	— (0.1)	6 (2)	2	59 (16)	—	40	7 (2)

Pd = paddy
Jk = jowar kharif
Jr = jowar rabi
B = bajra
M = maize
R = ragi
W = wheat
Ba = barley
Mt = small millets
G = gram
T = tur
Pu = other pulses
S = sugarcane
Gn = groundnut
O = other oilseeds
Misc = miscellaneous crops

NOTE : (1) The percentage figures have been rounded off individually and hence cross totals may not, in some cases, add up to 100.
(2) Figures in brackets are percentages to gross cropped area.

ERRATA

RAINFALL AND CROPPING PATTERNS

VOLUME XVI
WEST BENGAL

Page No.	Paragraph/Table/ Appendix No.	Line	As printed	As desired
(1)	(2)	(3)	(4)	(5)
Contents	Appendix 3		Principle	Principal
2	2.3	5	nature	mature
2	Table 1	Col. 1 against 20--30		B
5	3.4	4	has	have
5	3.4	4	soils	soils.
5	3.5	9	Purulia, Hooghly	Purulia,
5	Table 5	last col. row 2	272	72
6	3.8	2	Table	Tables
6	Do.	8	in near coast	near the coast
6	3.10	4	when	where
6	Table 7	col. 1 row 3	Berhampor	Berhampore
6	Do.	col. 2 row 5	13.3	12.3
7	Table 9	col. 4 row 1	11.9	119.9
7	4.4	2	cm	cm.
7	4.5	1	with	accounting for
8	4.13	1	yield	yields
8	4.15	3	average	averages
8	4.18	2	June and	June to
8	4.19	1	Area of	Area under
8	Do.	3	213,000	(213,000
9	4.39	3	of	in
10	5.2	7	at a	at the
11	Appendix 1	Rainfall Zone I		Rainfall Pattern—D_1 E_3 ($A_2B_1C_1$) $D_1 E_3$
11	Do.	Footnote m	male	male (over 3 years)
11	Do.	Footnote f	female	female (over 3 years)
11	Do.	Footnote ys	youngstock	youngstock (under 3 years)